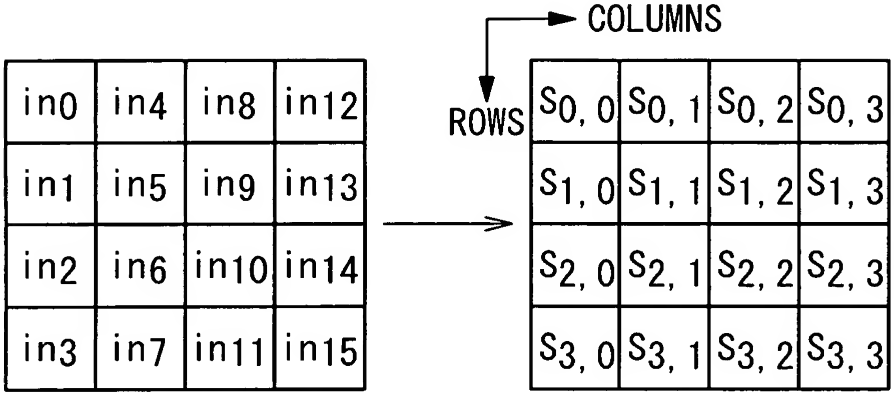
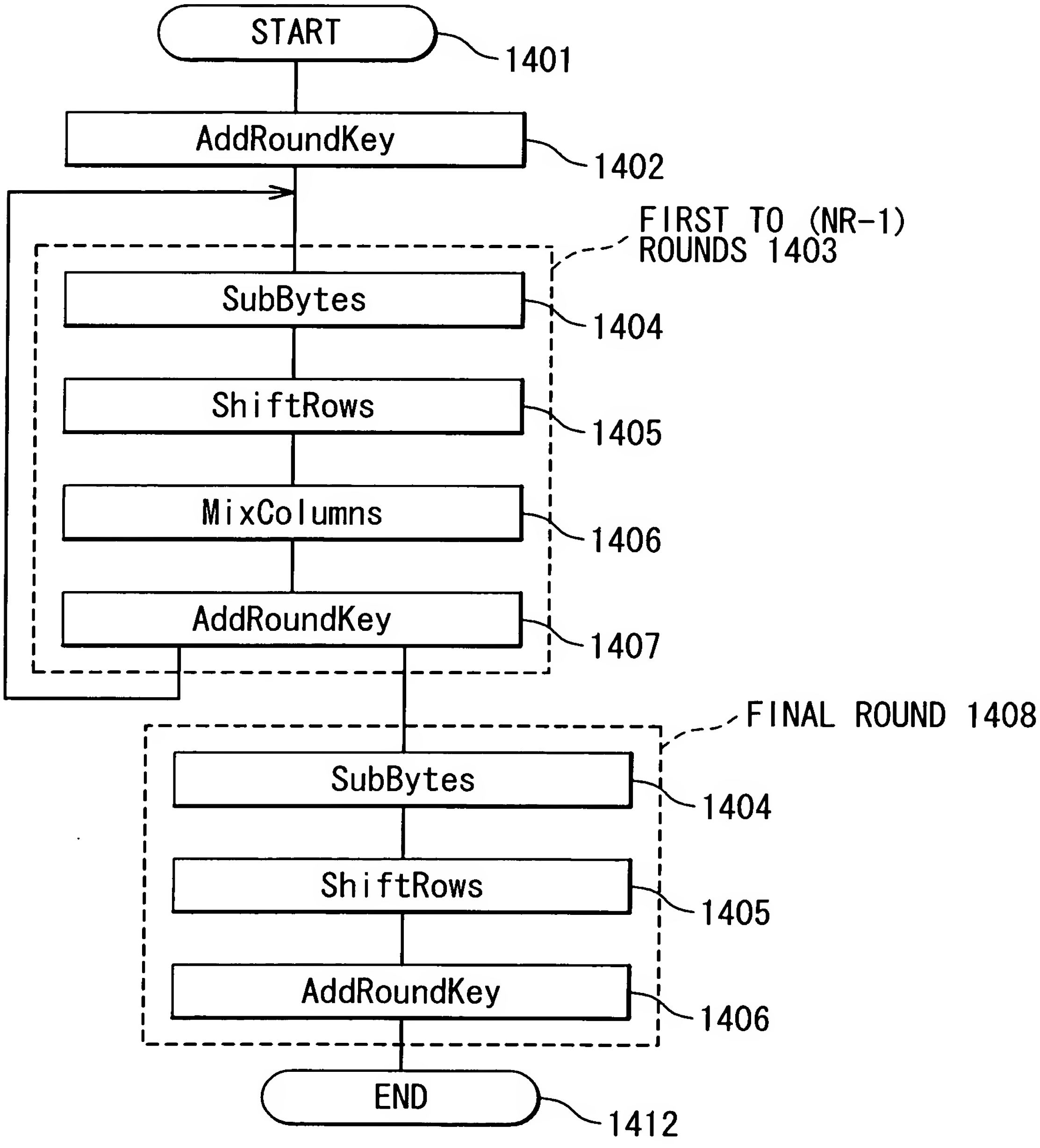
Fig. 1 PRIOR ART



in0	in4	in8	in12
in1	in5	in9	in13
in2	in6	in10	in14
in3	in7	in11	in15

$s_{0,0}$	$s_{0,1}$	$s_{0,2}$	$s_{0,3}$
$s_{1,0}$	$s_{1,1}$	$s_{1,2}$	$s_{1,3}$
$s_{2,0}$	$s_{2,1}$	$s_{2,2}$	$s_{2,3}$
$s_{3,0}$	$s_{3,1}$	$s_{3,2}$	$s_{3,3}$

Fig. 2 PRIOR ART



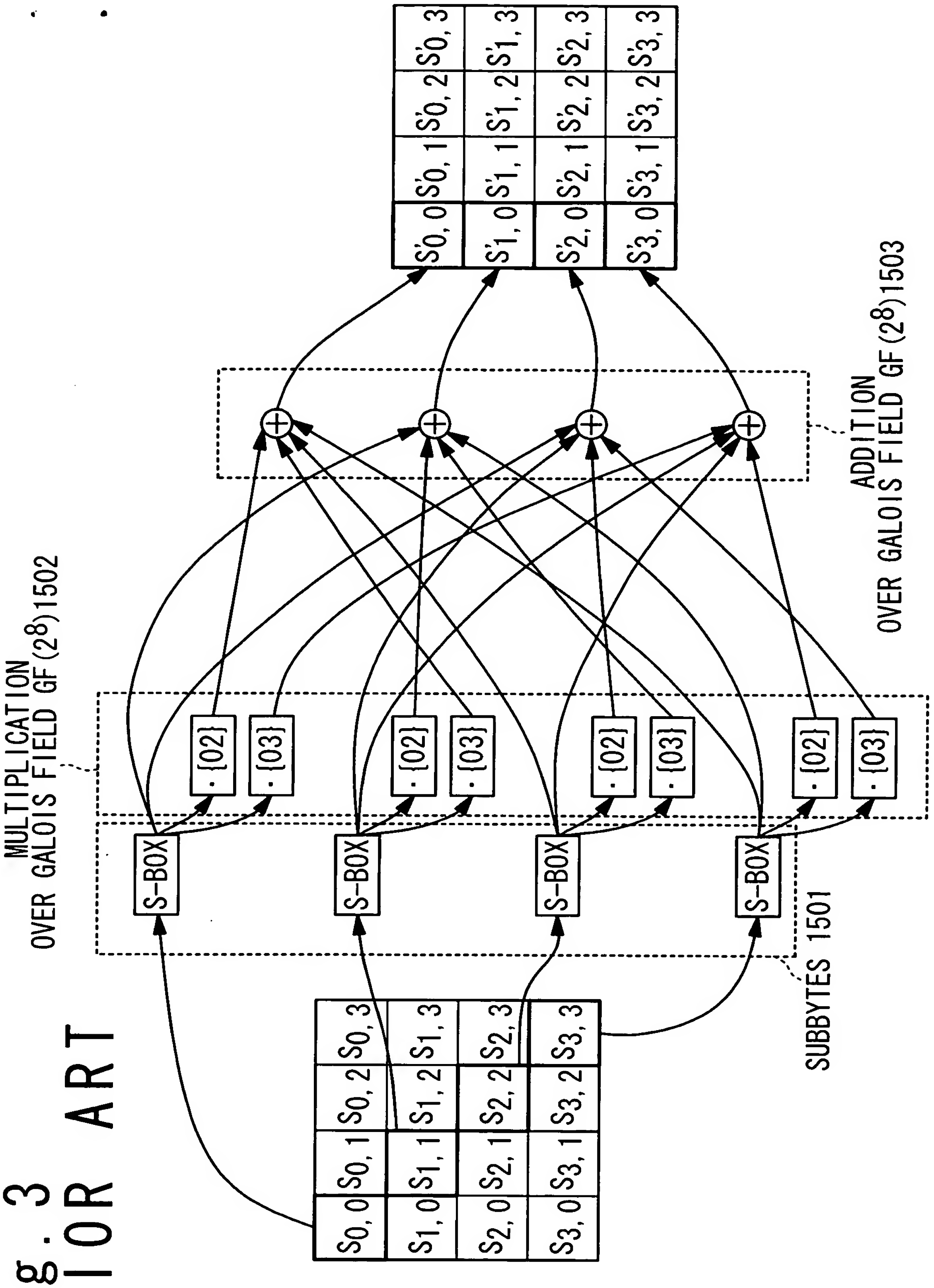
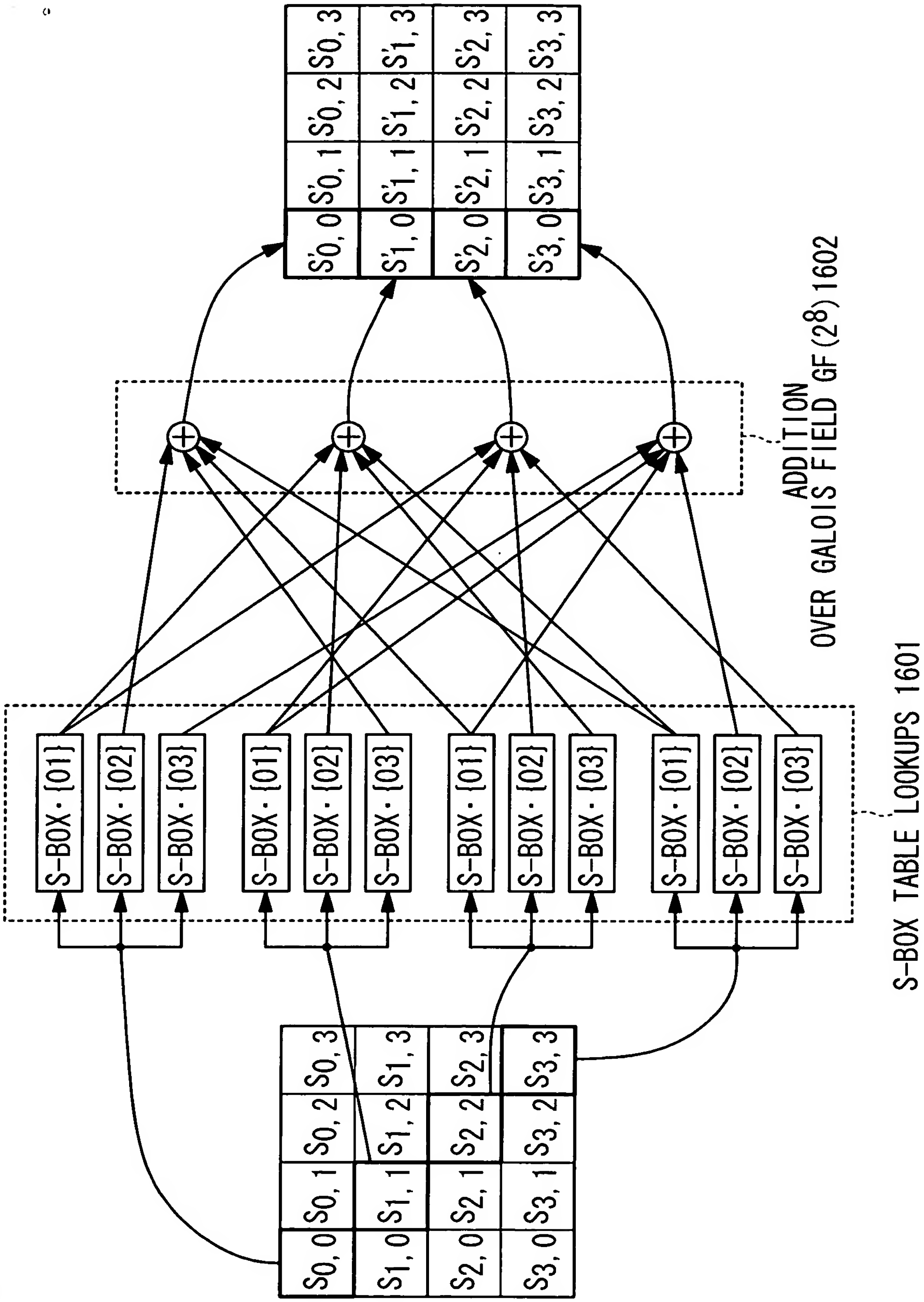


Fig.3
PRIOR ART

Fig. 4 PRIOR ART



Kouhei NADEHARA
"Implementations of AES Algorithm for Reducing
Hardware with Improved Efficiency"
Q79582-----Filed January 27, 2004-----Sheets 5 of 23

Fig. 5 PRIOR ART

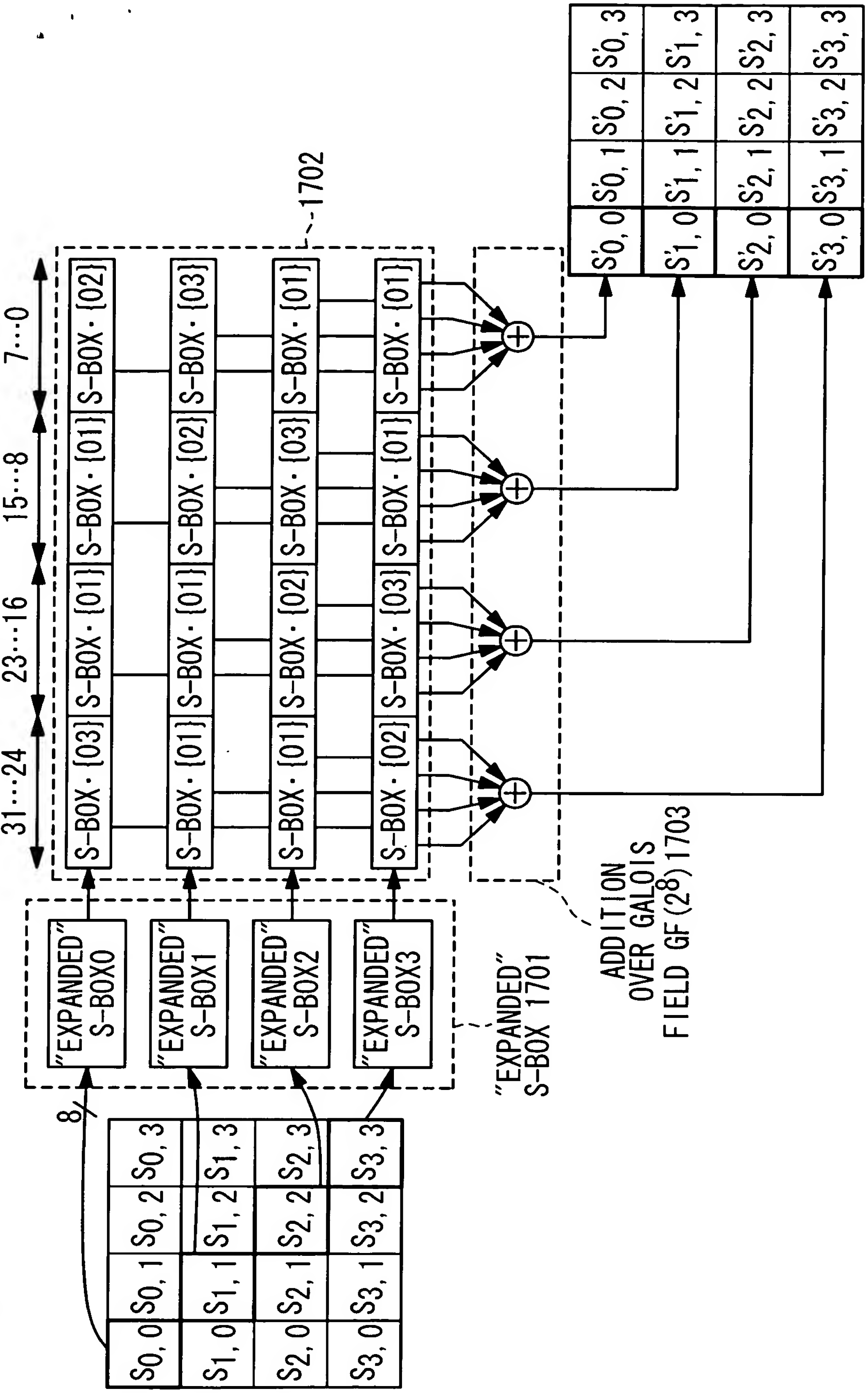


Fig. 6 PRIOR ART

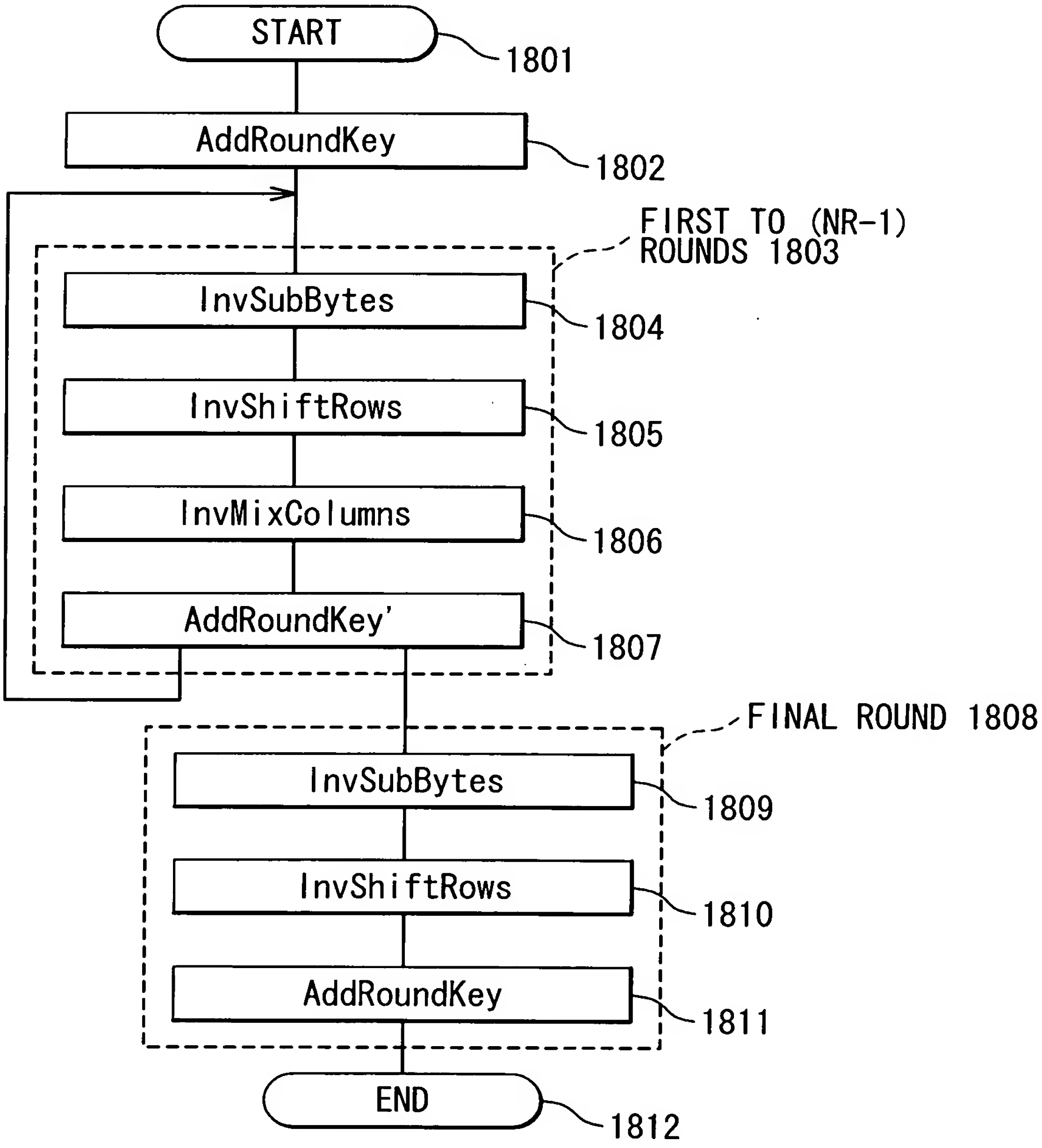


Fig. 7

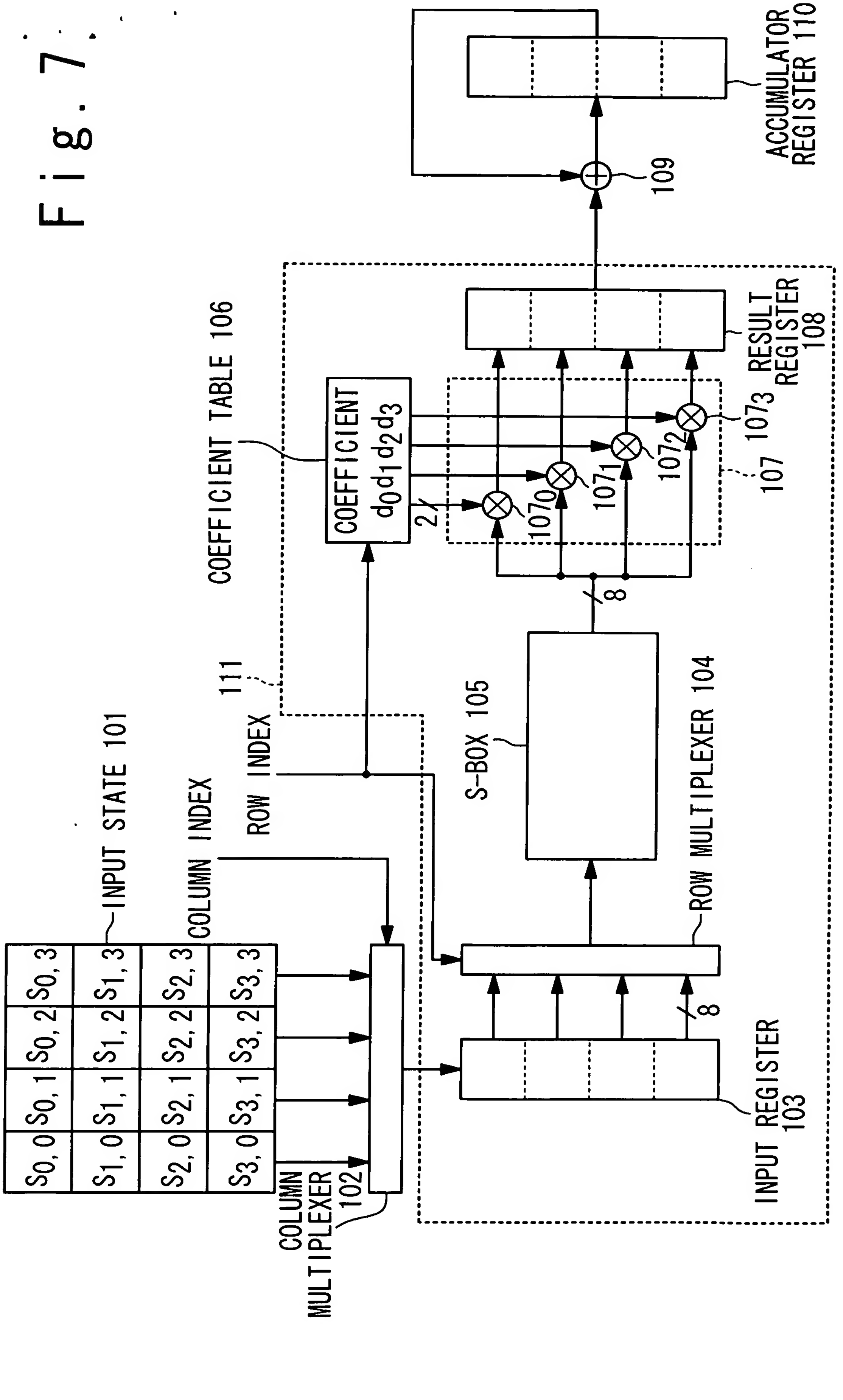

ACCUMULATOR REGISTER 110
109
RESULT REGISTER 108
COEFFICIENT TABLE 106
COEFFICIENT
$d_0 d_1 d_2 d_3$
2
107_0
107_1
107_2
107_3
107
8
111
ROW INDEX
S-BOX 105
ROW MULTIPLEXER 104
INPUT STATE 101
COLUMN INDEX
COLUMN
$S_{0,0}$
$S_{0,1}$
$S_{0,2}$
$S_{0,3}$
$S_{1,0}$
$S_{1,1}$
$S_{1,2}$
$S_{1,3}$
$S_{2,0}$
$S_{2,1}$
$S_{2,2}$
$S_{2,3}$
$S_{3,0}$
$S_{3,1}$
$S_{3,2}$
$S_{3,3}$
COLUMN MULTIPLEXER 102
INPUT REGISTER 103
8

Fig. 8

ROW INDEX	OUTPUT OF COEFFICIENT TABLE			
	d_3	d_2	d_1	d_0
0	{02}	{01}	{01}	{03}
1	{03}	{02}	{01}	{01}
2	{01}	{03}	{02}	{01}
3	{01}	{01}	{03}	{02}

Fig. 9

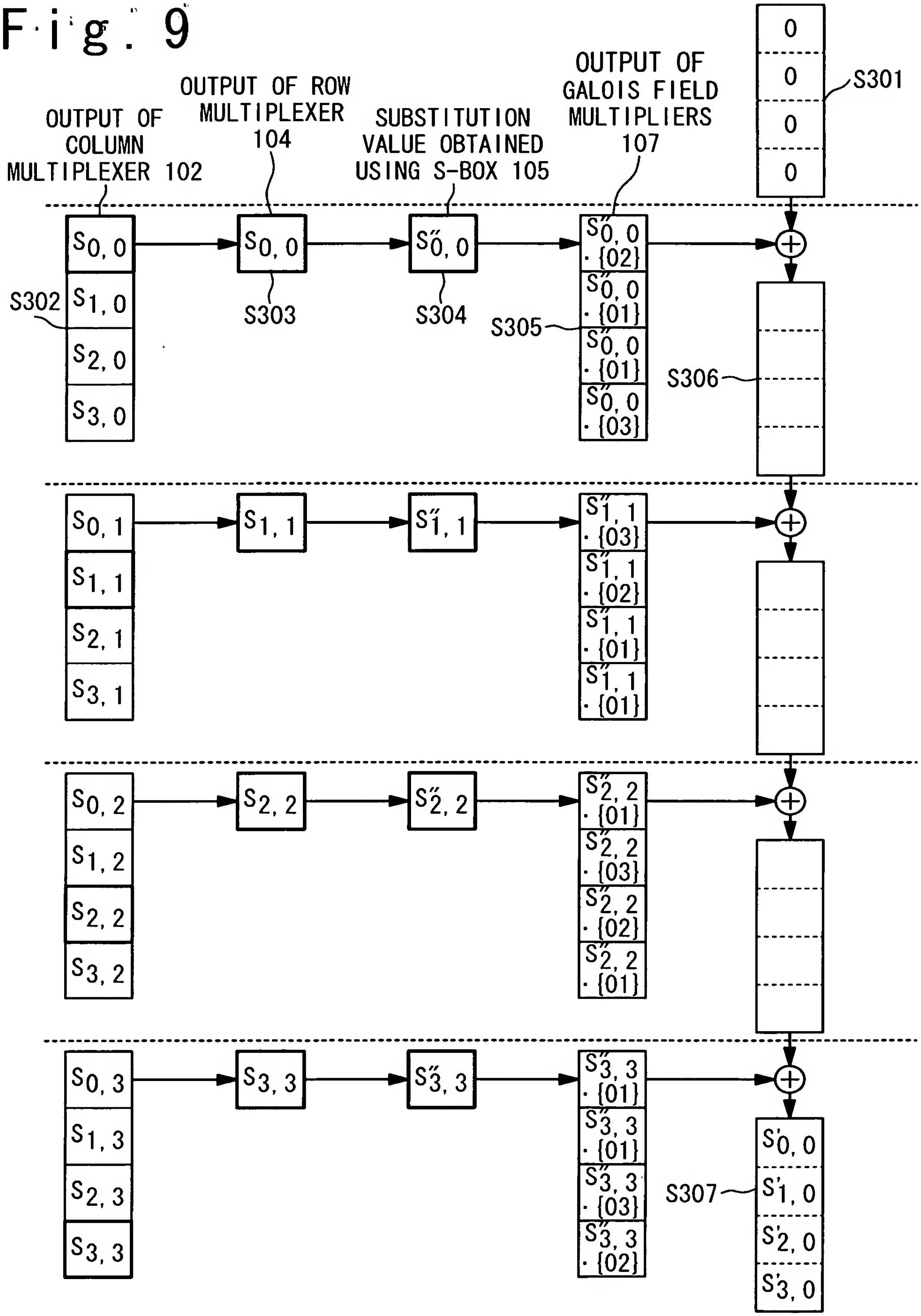

OUTPUT OF COLUMN MULTIPLEXER 102
OUTPUT OF ROW MULTIPLEXER 104
SUBSTITUTION VALUE OBTAINED USING S-BOX 105
OUTPUT OF GALOIS FIELD MULTIPLIERS 107
0
0
0
0
S301
$S_{0,0}$
$S_{1,0}$
$S_{2,0}$
$S_{3,0}$
S302
$S_{0,0}$
S303
$S''_{0,0}$
S304
$S''_{0,0} \cdot \{02\}$
$S''_{0,0} \cdot \{01\}$
$S''_{0,0} \cdot \{01\}$
$S''_{0,0} \cdot \{03\}$
S305
S306
$S_{0,1}$
$S_{1,1}$
$S_{2,1}$
$S_{3,1}$
$S_{1,1}$
$S''_{1,1}$
$S''_{1,1} \cdot \{03\}$
$S''_{1,1} \cdot \{02\}$
$S''_{1,1} \cdot \{01\}$
$S''_{1,1} \cdot \{01\}$
$S_{0,2}$
$S_{1,2}$
$S_{2,2}$
$S_{3,2}$
$S_{2,2}$
$S''_{2,2}$
$S''_{2,2} \cdot \{01\}$
$S''_{2,2} \cdot \{03\}$
$S''_{2,2} \cdot \{02\}$
$S''_{2,2} \cdot \{01\}$
$S_{0,3}$
$S_{1,3}$
$S_{2,3}$
$S_{3,3}$
$S_{3,3}$
$S''_{3,3}$
$S''_{3,3} \cdot \{01\}$
$S''_{3,3} \cdot \{01\}$
$S''_{3,3} \cdot \{03\}$
$S''_{3,3} \cdot \{02\}$
S307
$S'_{0,0}$
$S'_{1,0}$
$S'_{2,0}$
$S'_{3,0}$

Fig. 10

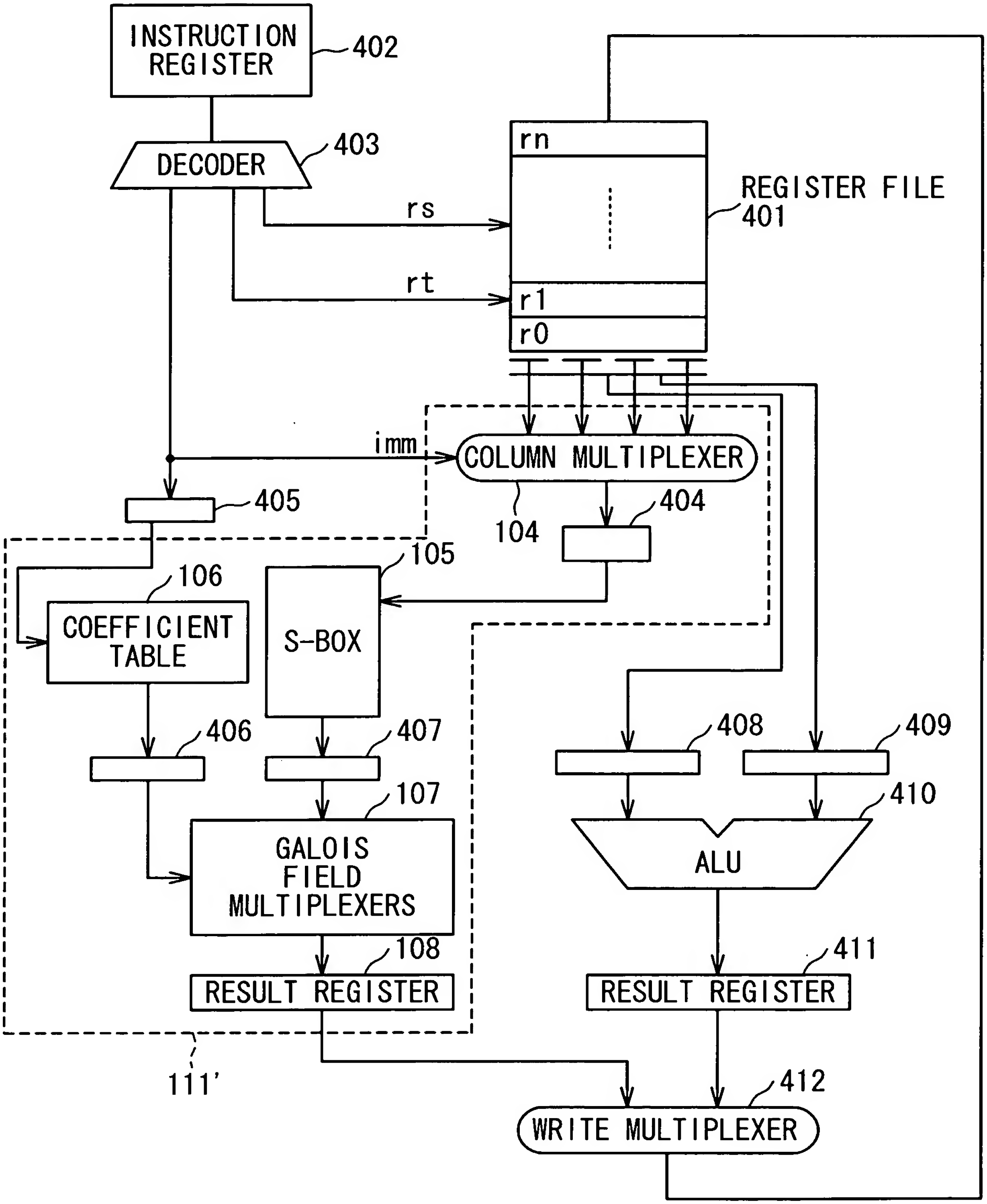

INSTRUCTION REGISTER
402
DECODER
403
rs
rt
rn
r1
r0
REGISTER FILE
401
imm
COLUMN MULTIPLEXER
104
404
405
105
106
COEFFICIENT TABLE
S-BOX
406
407
GALOIS FIELD MULTIPLEXERS
107
108
RESULT REGISTER
111'
408
409
410
ALU
411
RESULT REGISTER
412
WRITE MULTIPLEXER

Fig. 11A

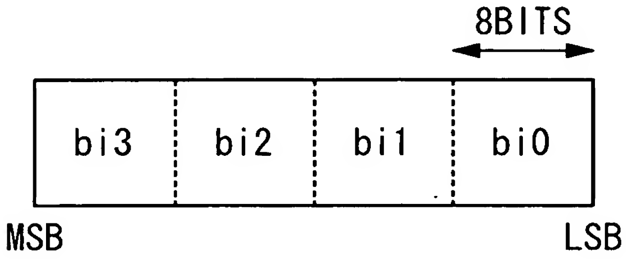


Fig. 11B

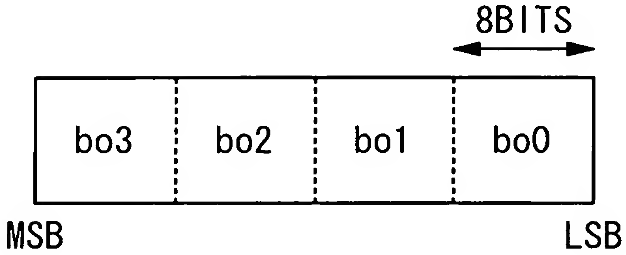


Fig. 12

imm	rt			
	bo3	bo2	bo1	bo0
00	S-BOX(bi0)・{02}	S-BOX(bi0)・{01}	S-BOX(bi0)・{01}	S-BOX(bi0)・{03}
01	S-BOX(bi1)・{03}	S-BOX(bi1)・{02}	S-BOX(bi1)・{01}	S-BOX(bi1)・{01}
02	S-BOX(bi2)・{01}	S-BOX(bi2)・{03}	S-BOX(bi2)・{02}	S-box(bi2)・{01}
03	S-BOX(bi3)・{01}	S-BOX(bi3)・{01}	S-BOX(bi3)・{03}	S-BOX(bi3)・{02}

Fig. 13

```
; INPUT:
; r0=[S3,0  S2,0  S1,0  S0,0]
; r1=[S3,1  S2,1  S1,1  S0,1]
; r2=[S3,2  S2,2  S1,2  S0,2]
; r3=[S3,3  S2,3  S1,3  S0,3]
;
; WORK REGISTER:r4
; ACCUMULATOR REGISTER:r5
;
; OUTPUT:
; r5=[S'3,0 S'2,0 S'1,0 S'0,0]
;
AES_SSM r0,r5,0  ; S0,0=r0, bi0
AES_SSM r1,r4,1  ; S1,1=r1, bi1
XOR     r5,r4,r5 ; r5=r5 XOR r4
AES_SSM r2,r4,2  ; S2,2=r2, bi2
XOR     r5,r4,r5 ; r5 =r5 XOR r4
AES_SSM r3,r4,3  ; S3,3=r3, bi3
XOR     r5,r4,r5 ; r5=r5 XOR r4
```

Fig. 14

ROW INDEX	OUTPUT OF COEFFICIENT TABLE			
	d_3	d_2	d_1	d_0
0	{0e}	{09}	{0d}	{0b}
1	{0b}	{0e}	{09}	{0d}
2	{0d}	{0b}	{0e}	{09}
3	{09}	{0d}	{0b}	{0e}

Fig. 15

imm	rt			
	bo3	bo2	bo1	bo0
00	INVS-BOX (bi0) · {0e}	INVS-BOX (bi0) · {09}	INVS-BOX (bi0) · {0d}	INVS-BOX (bi0) · {0b}
01	INVS-BOX (bi1) · {0b}	INVS-BOX (bi1) · {0e}	InvS-box (bi0) · {09}	INVS-BOX (bi1) · {0d}
02	INVS-BOX (bi2) · {0d}	INVS-BOX (bi2) · {0b}	INVS-BOX (bi2) · {0e}	INVS-BOX (bi2) · {09}
03	InvS-box (bi3) · {09}	InvS-box (bi3) · {0d}	INVS-BOX (bi3) · {0b}	INVS-BOX (bi3) · {0e}

Fig. 16

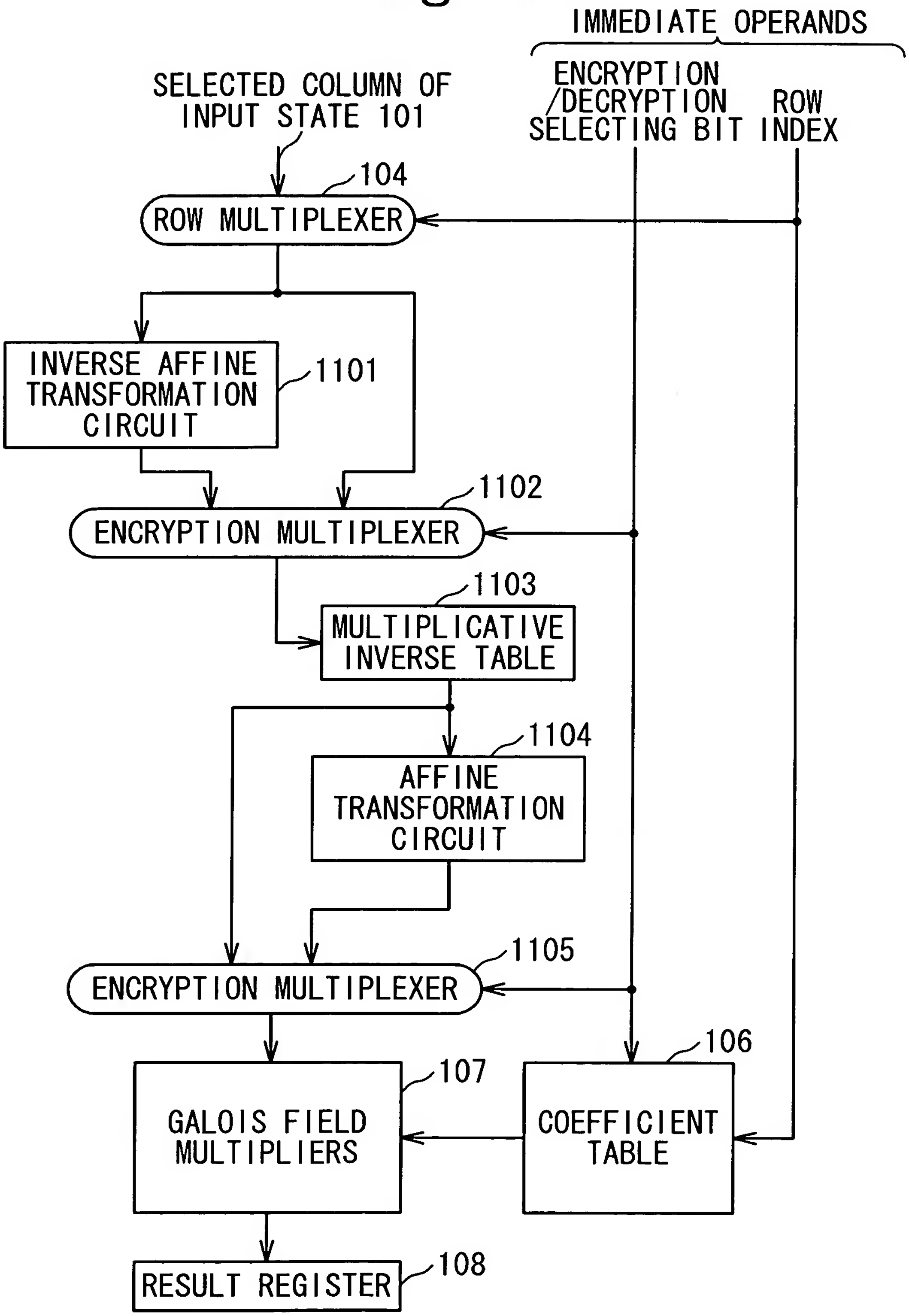

IMMEDIATE OPERANDS
SELECTED COLUMN OF INPUT STATE 101
ENCRYPTION /DECRYPTION SELECTING BIT
ROW INDEX
104
ROW MULTIPLEXER
INVERSE AFFINE TRANSFORMATION CIRCUIT
1101
1102
ENCRYPTION MULTIPLEXER
1103
MULTIPLICATIVE INVERSE TABLE
1104
AFFINE TRANSFORMATION CIRCUIT
1105
ENCRYPTION MULTIPLEXER
106
107
GALOIS FIELD MULTIPLIERS
COEFFICIENT TABLE
RESULT REGISTER
108

Fig. 17

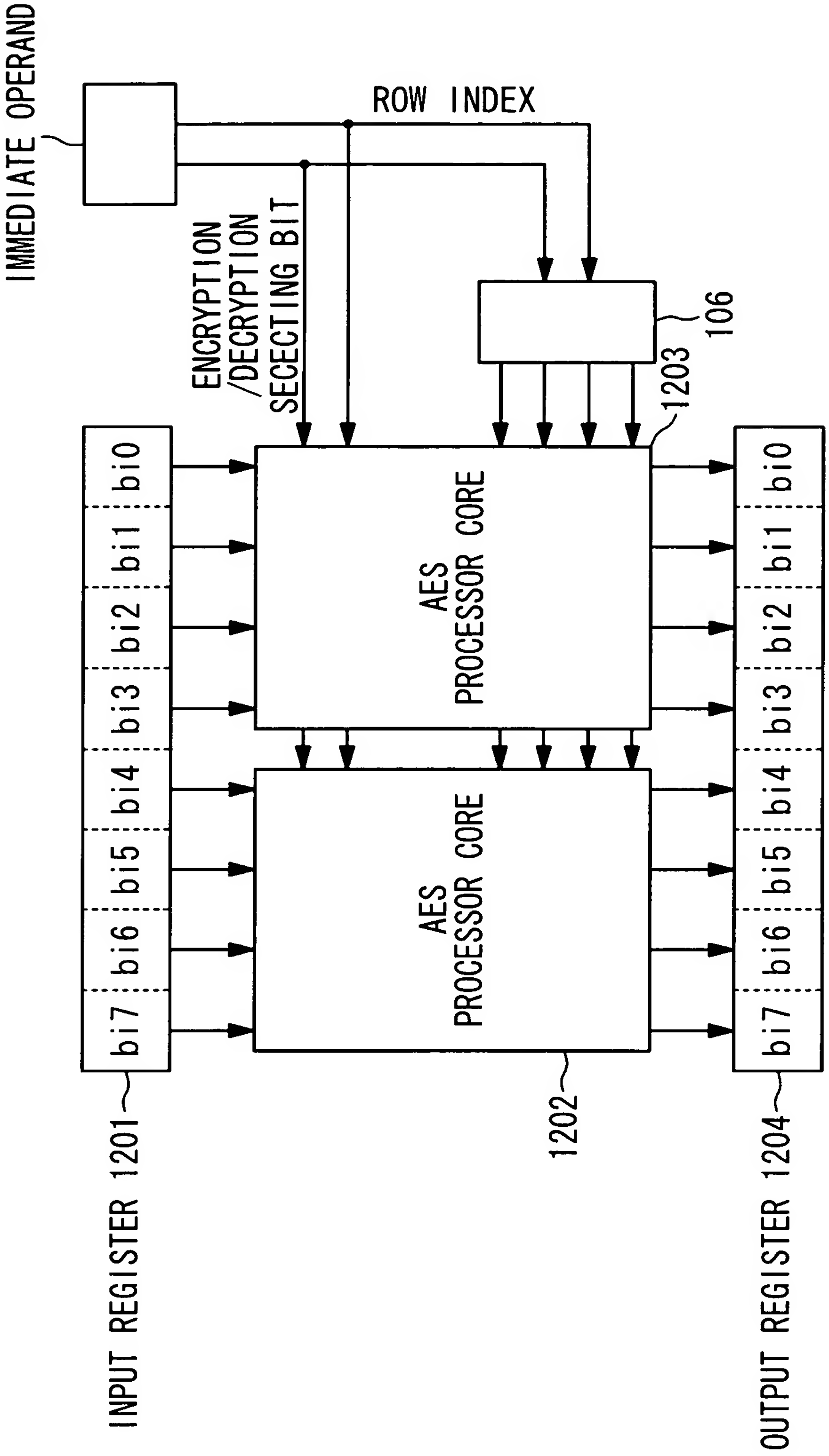

IMMEDIATE OPERAND
ROW INDEX
ENCRYPTION
/DECRYPTION
SECECTING BIT
106
1203
AES
PROCESSOR CORE
AES
PROCESSOR CORE
bi0
bi1
bi2
bi3
bi4
bi5
bi6
bi7
bi0
bi1
bi2
bi3
bi4
bi5
bi6
bi7
INPUT REGISTER 1201
1202
OUTPUT REGISTER 1204

Fig. 18

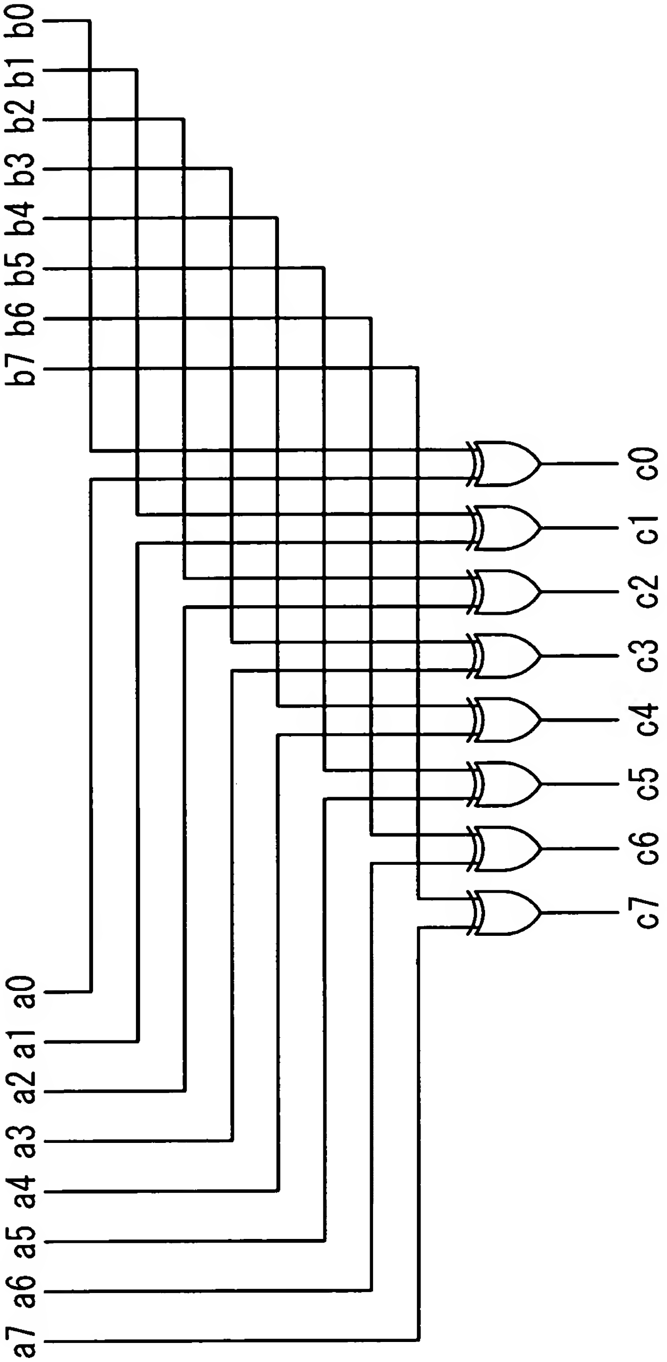


Fig. 19

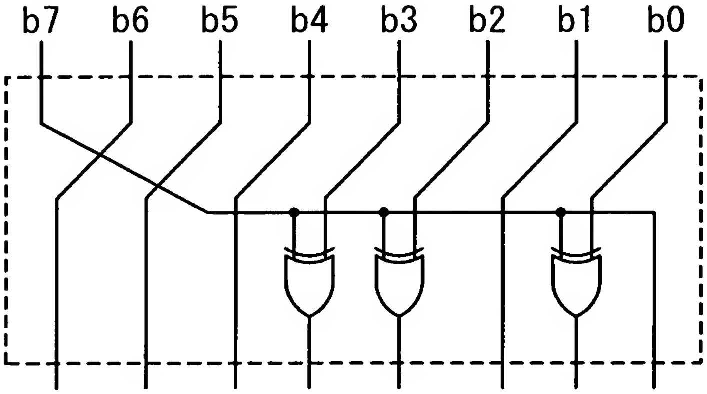


Fig. 20

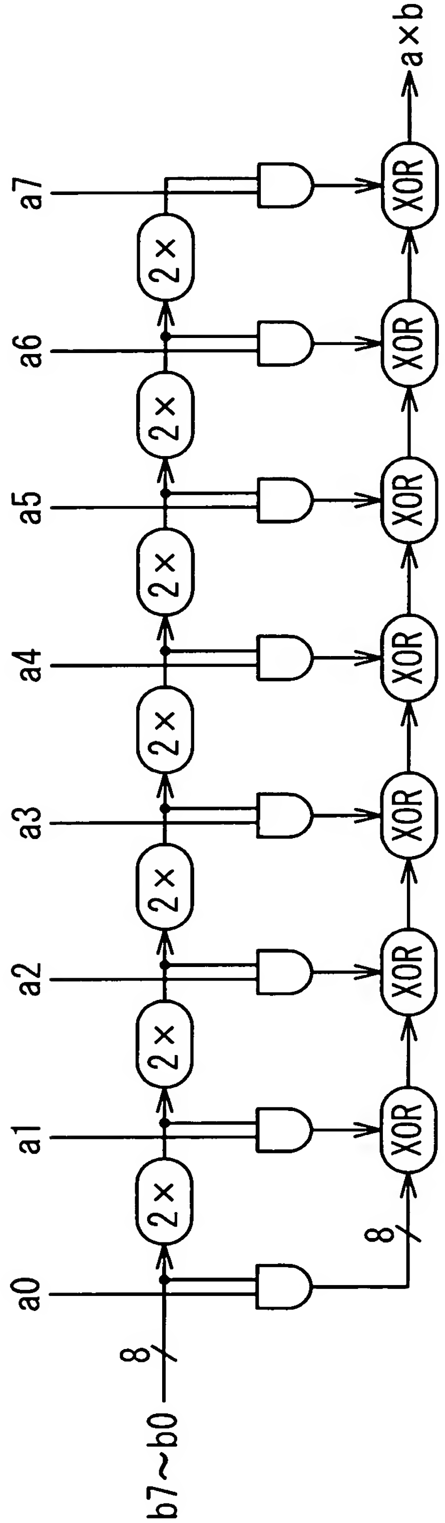


Fig. 21

		y															
		0	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f
f	0	63	7c	77	7b	f2	6b	6f	c5	30	01	67	2b	fe	d7	ab	76
	1	ca	82	c9	7d	fa	59	47	f0	ad	d4	a2	af	9c	a4	72	c0
	2	b7	fd	93	26	36	3f	f7	cc	34	a5	e5	f1	71	d8	31	15
	3	04	c7	23	c3	18	96	05	9a	07	12	80	e2	eb	27	b2	75
	4	09	83	2c	1a	1b	6e	5a	a0	52	3b	d6	b3	29	e3	2f	84
	5	53	d1	00	ed	20	fc	b1	5b	6a	cb	be	39	4a	4c	58	cf
	6	d0	ef	aa	fb	43	4d	33	85	45	f9	02	7f	50	3c	9f	a8
	7	51	a3	40	8f	92	9d	38	f5	bc	b6	da	21	10	ff	f3	d2
	8	cd	0c	13	ec	5f	97	44	17	c4	a7	7e	3d	64	5d	19	73
	9	60	81	4f	dc	22	2a	90	88	46	ee	b8	14	de	5e	0b	db
	a	e0	32	3a	0a	49	06	24	5c	c2	d3	ac	62	91	95	e4	79
	b	e7	c8	37	6d	8d	d5	4e	a9	6c	56	f4	ea	65	7a	ae	08
	c	ba	78	25	2e	1c	a6	b4	c6	e8	dd	74	1f	4b	bd	8b	8a
	d	70	3e	b5	66	48	03	f6	0e	61	35	57	b9	86	c1	1d	9e
	e	e1	f8	98	11	69	d9	8e	94	9b	1e	87	e9	ce	55	28	df
	f	8c	a1	89	0d	bf	e6	42	68	41	99	2d	0f	b0	54	bb	16

Fig. 22

		y															
		0	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f
f	0	52	09	6a	d5	30	36	a5	38	bf	40	a3	9e	81	f3	d7	fb
	1	7c	e3	39	82	9b	2f	ff	87	34	8e	43	44	c4	de	e9	cb
	2	54	7b	94	32	a6	c2	23	3d	ee	4c	95	0b	42	fa	c3	4e
	3	08	2e	a1	66	28	d9	24	b2	76	5b	a2	49	6d	8b	d1	25
	4	72	f8	f6	64	86	68	98	16	d4	a4	5c	cc	5d	65	b6	92
	5	6c	70	48	50	fd	ed	b9	da	5e	15	46	57	a7	8d	9d	84
	6	90	d8	ab	00	8c	bc	d3	0a	f7	e4	58	05	b8	b3	45	06
	7	d0	2c	1e	8f	ca	3f	0f	02	c1	af	bd	03	01	13	8a	6b
	8	3a	91	11	41	4f	67	dc	ea	97	f2	cf	ce	f0	b4	e6	73
	9	96	ac	74	22	e7	ad	35	85	e2	f9	37	e8	1c	75	df	6e
	a	47	f1	1a	71	1d	29	c5	89	6f	b7	62	0e	aa	18	be	1b
	b	fc	56	3e	4b	c6	d2	79	20	9a	db	c0	fe	78	cd	5a	f4
	c	1f	dd	a8	33	88	07	c7	31	b1	12	10	59	27	80	ec	5f
	d	60	51	7f	a9	19	b5	4a	0d	2d	e5	7a	9f	93	c9	9c	ef
	e	a0	e0	3b	4d	ae	2a	f5	b0	c8	eb	bb	3c	83	53	99	61
	f	17	2b	04	7e	ba	77	d6	26	e1	69	14	63	55	21	0c	7d

Fig. 23

		y															
		0	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f
f	0	00	01	8d	f6	cb	52	7b	d1	e8	4f	29	c0	b0	e1	e5	c7
	1	74	b4	aa	4b	99	2b	60	5f	58	3f	fd	cc	ff	40	ee	b2
	2	3a	6e	5a	f1	55	4d	a8	c9	c1	0a	98	15	30	44	a2	c2
	3	2c	45	92	6c	f3	39	66	42	f2	35	20	6f	77	bb	59	19
	4	1d	fe	37	67	2d	31	f5	69	a7	64	ab	13	54	25	e9	09
	5	ed	5c	05	ca	4c	24	87	bf	18	3e	22	f0	51	ec	61	17
	6	16	5e	af	d3	49	a6	36	43	f4	47	91	df	33	93	21	3b
	7	79	b7	97	85	10	b5	ba	3c	b6	70	d0	06	a1	fa	81	82
	8	83	7e	7f	80	96	73	be	56	9b	9e	95	d9	f7	02	b9	a4
	9	de	6a	32	6d	d8	8a	84	72	2a	14	9f	88	f9	dc	89	9a
	a	fb	7c	2e	c3	8f	b8	65	48	26	c8	12	4a	ce	e7	d2	62
	b	0c	e0	1f	ef	11	75	78	71	a5	8e	76	3d	bd	bc	86	57
	c	0b	28	2f	a3	da	d4	e4	0f	a9	27	53	04	1b	fc	ac	e6
	d	7a	07	ae	63	c5	db	e2	ea	94	8b	c4	d5	9d	f8	90	6b
	e	b1	0d	d6	eb	c6	0e	cf	ad	08	4e	d7	e3	5d	50	1e	b3
	f	5b	23	38	34	68	46	03	8c	dd	9c	7d	a0	cd	1a	41	1c